DIAGNOSTIC ASSAYS AND RELATED METHODS

RELATED APPLICATIONS

[0001] This Application claims priority under 35 U.S.C. § 119(e) to U.S. Provisional Patent Application No. 63/085,929, filed Sep. 30, 2020, entitled "WHITE LIGHT EMISSIVE SPECIES AND RELATED METHODS," to U.S. Provisional Patent Application No. 63/069,544, filed Aug. 24, 2020, entitled "DIAGNOSTIC ASSAYS AND RELATED METHODS," to U.S. Provisional Patent Application No. 63/054,176, filed July 20, 2020, entitled "TEMPORAL THERMAL SENSING AND RELATED METHODS," and to U.S. Provisional Patent Application No. 62/916,331, filed Oct. 17, 2019, entitled "LUMINESCENCE IMAGING FOR SENSING AND/OR AUTHENTICATION," the contents of each of which are hereby incorporated by reference in their entirety for all purposes.

FIELD

[0002] Embodiments described herein generally relate to: sensing and/or authentication using luminescence imaging; diagnostic assays, systems, and related methods; temporal thermal sensing and related methods; and/or to emissive species, such as those excitable by white light, and related systems and methods.

BACKGROUND

[0003] Sensing technology is being used in a wide variety of applications such as safety, security, process monitoring, and air quality control. However, many sensors are limited by complex manufacturing processes, low sensitivity, and/or false indications of detection. As such, the applications of such sensors are often limited.

[0004] Many products can be damaged when exposed to temperatures above or below a threshold level for a period of time. Products at risk of degradation include biological materials, tissue, medicines, food, beverages, electronics, live cells, organs, livestock, and the like. It is often the case that it is not simply the peak temperature that is most important, but may also include the time spent at a given temperature. For example, a short time at a higher temperature can cause similar degradation to a product as a longer time at a lower temperature exceeding a threshold value. In simple terms the product of the temperature and time is an important metric. Materials and methods capable of providing this information may include time temperature indicators (TTI) and/or dosimetric labels when applied to packaging. For example, thermally activated color changes in a dosimeter label are one way to monitor such changes. However, these methods have limited utility and new methods that provide more information which can be readily captured by readers and greater precision are needed.

[0005] Molecular and biological diagnostic tests generally leveraging the low-cost nature and ubiquity of lateral flow assays as well as vertical flow assays and genetic assays based on biological components such as antigens, antibodies, and nucleotides are critical to ensuring public health and safety. Although these assays are easy to use, they are typically analyzed visually using the human eye which injects a high degree of variability and/or subjectivity into the data interpretation. To address this shortcoming, new approaches employing automation and machine vision are necessary to improve the sensitivity and accuracy of lateral flow assays. Although smartphones have recently been used to provide high-resolution image acquisition and analysis, these methods are still limited.

[0006] Accordingly, improved methods and systems are needed.

SUMMARY

[0007] Articles, systems, and methods for luminescence imaging for sensing and/or authentication are generally disclosed.

[0008] In some aspects, an imaging device is provided. In some embodiments, the imaging device comprises a source of electromagnetic radiation configured to emit radiation to excite non-steady-state emission in emissive species during emission time periods (e.g., emission lifetime) of the emissive species. In some embodiments, the emission time period is at least 10 nanoseconds. In some embodiments, an electromagnetic radiation sensor comprising a plurality of photodetectors is arranged in an array of rows and columns, wherein the electromagnetic radiation sensor is configured to sense the non-steady-state emission from the emissive species during the emission time period and processing circuitry configured to sequentially read out rows or columns of the array to provide a plurality of time-encoded signals and identify a characteristic of the emissive species based on a comparison of at least two of the plurality of time-encoded signals.

[0009] In some embodiments, the imaging device comprises a source of electromagnetic radiation configured to emit radiation to excite non-steady-state emission in emissive species during emission time periods of the emissive species, the emission time periods being at least 10 nanoseconds, an electromagnetic radiation sensor comprising a plurality of photodetectors arranged in an array of rows and columns, wherein the electromagnetic radiation sensor is configured to sense the non-steady-state emission from the emissive species during the emission time period and processing circuitry configured to globally expose and/or read data from the electromagnetic radiation sensor to provide a plurality of time-encoded signals and identify a characteristic of the emissive species based on a comparison of two or more of the plurality of time-encoded signals.

[0010] In some embodiments, the processing circuitry is further configured to generate one or more images based on the plurality of time-encoded signals, and wherein identifying the characteristic of the emissive species is based on the one or more images.

[0011] In some aspects, a system is provided. In some embodiments, the system comprises an excitation component configured to excite an emissive species such that the emissive species produces a detectable non-steady-state emission during an emission time period. In some embodiments, the emission time period is at least 10 nanoseconds. In some embodiments, the system comprises an image sensor configured to detect at least a portion of the detectable non-steady-state emission. In some embodiments, the system comprises an electronic hardware component configured to produce a single image comprising a first portion corresponding to a first portion of the emission time period and a second portion corresponding to a second portion of the emission time period.

[0012] In some embodiments, the system comprises an excitation component configured to expose an emissive